THE RELATIONSHIP BETWEEN LEVEL OF

ACTIVATION AND REACTION TIME

by

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Introduction

This is a pilot study, the purpose of which is to test the hypothesis that there is a curvilinear relationship between the level of activation and reaction time.

Before getting into the more technical aspects of the problem, definition of the basic concepts involved is a necessity.

The layman in his every-day life constantly refers to some of the states included in the concept of level of activation. At various times he speaks of himself or others as being highly emotional, tense, excited, alert, or motivated. At other times he speaks of himself as being drowsy, relaxed, or unmotivated. Although he may think he knows precisely what he means by these terms, they are difficult to define exactly. All of these states are included in the concept of level of activation, and by using this concept confusion caused by the overlapping and lack of precision in the preceding terms can be avoided. In fact, Duffy[1] presented level of activation along with the behavioral dimension of direction (the approach or withdrawal or tendency toward or away from

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[1]E. Duffy, "Emotion: An Example of the Need for Reorientation in Psychology," Psychological Review, Vol. 41 (1934), pp. 184-198; "The Conceptial Categories of Psychology: A Suggestion for Revision," Psychological Review, Vol. 48 (1941), pp. 177-203; and "An Explanation of 'Emotional' Phenomena Without the Use of the Concept 'Emotion!,'" Journal of General Psychology, Vol. 25 (1941), pp. 283-293.

a stimulus) as a substitute for such poorly defined constructs as those of emotion, motivation, and others. As she defines it, level of activation is "the degree of energy-release within the organism..."[2] and it represents "changes in the internal processes associated with the release of energy."[3]

This is a more inclusive definition than that of Woodworth and Schlosberg, who say, "level of activation...is to be understood as the factor...common to many of the bodily changes involved in 'emotion'."[4] The Woodworth and Schlosberg definition hinges on, and is limited by, the term "emotion," one of the terms for which Duffy's concept is a substitute.

Highly important to Duffy's concept of level of activation is the fact that it stands for a continuum with sleep at one end and states of unusual excitement or arousal at the other. Because it does represent a continuum there are no sharp divisions, thus eliminating the necessity for distinguishing between such states, for example, as emotion and non-emotion. Each would simply be a point on the continuum representing a certain level of activation.

Another important aspect of the concept is that it is defined in terms of physiological processes and the change in these processes which occurs in response to certain changes or stimuli in the environment. One

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[2]E. Duffy, Activation and Behavior. Manuscript in preparation.

[3]Ibid.

[4]R. S. Woodworth and H. Schlosberg, Experimental Psychology, rev. ed. (New York: Henry Holt and Co., 1954), p. 136.

might say that the level of activation represents the general rate of activity of most of these processes.[5] The scientific soundness of the concept lies in its basis in physiological activity which can be measured with a fair degree of accuracy.

In measuring level of activation, one measures a basic dimension of behavior: intensity of response, be the response overt or covert.[6] Therefore, a more satisfactory definition of level of activation would be "the extent of release of potential energy, stored in the tissues of the organism, as this is shown in activity or response."[7]

The actual measurement of activation is not yet standardized. An experimenter may choose from several measures which seem to show variations indicative of changes in the level of activation. Muscle tension, blood-pressure, the electroencephalogram, skin resistance (or conductance), pulse rate, body and skin temperatures--all seem to show this variation.[8] Because the electrical activity of the skin was measured in this study, it merits further consideration.

According to Woodworth and Schlosberg, a key factor in activation is the activity of the autonomic nervous system, and

> One of the best indices of its activity is electrical conductance of the skin [or the degree of conductivity of the skin when a

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[5]E. Duffy, "The Concept of Energy Mobilization," Psychological Review, Vol. 58, No. 1 (January, 1951), pp. 30-39.

[6]E. Duffy, "The Psychological Significance of the Concept of 'Arousal' or 'Activation'," Psychological Review, Vol. 64, No. 5 (September, 1957), pp. 265-274.

[7]E. Duffy, Activation and Behavior, op. cit.

[8]Ibid., Chapter II.

> minute electric current is passed through its surface.] It seems to be a good measure of the general level of activation, for conductance is high when O [subject] is alert, and low when he is relaxed.[9]

This statement refers to the absolute level of conductance and not to the galvanic skin response, a rapid variation in conductance caused by a stimulus. Since conductance constantly fluctuates, the only distinction between the absolute level of conductance and the galvanic skin response seems to be the time of recording. In the first instance, conductance is recorded at specific intervals. In the second, conductance is recorded only when it changes rapidly in response to a stimulus.

It is generally accepted that electrical conductance of the skin is connected with sweat-gland activity, and that the palms of the hands and soles of the feet, although reflecting this activity, are not as closely concerned with maintenance of the optimal body temperature as are other areas.

Darrow presents the theory that palmar sweating is a facilitative response

> obviously affording a better grip upon objects, and when there is an imminent demand for action, the mechanisms of palmar sweat secretion prepare automatically for ensuing manipulative activity ...the adhesiveness and pliability of the palmar surfaces contribute materially to the keenness of tactual acuity.[10]

From this point of view, palmar sweating would occur when the level of activation rises, preparing the organism for immediate response.

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[9]Woodworth and Schlosberg, op. cit., p. 137.

[10]C. W. Darrow, "The Galvanic Skin Reflex (Sweating) and Blood-Pressure as Preparatory and Facilitative Functions," Psychological Bulletin, Vol. 33 (1936), p. 75.

According to others, however, the difference between the palmar and plantar areas and other areas may be one of rapidity of response. The palmar and plantar areas respond:

> quickly to changes in the energy demands of the situation, and they respond to small differences in such demands... Whatever the cause of the differences in their reactions...[these areas] have been found more useful [than other areas] in the study of behavioral correlates of changes in resistance [the reciprocal of conductance].[11]

The general purpose of this study was to investigate the relationship between activation and performance. Reaction time was used as a measure of performance. Reaction time, a simple motor response, is the interval between the perception of a stimulus by the subject and the initiation of an overt response by that subject. It is a comparatively uncomplicated method for discovering how long it takes an organism to respond. Perhaps for this reason, Schlosberg and Kling have called reaction time a measure of efficiency.[12]

As in any learned response, repetition of the stimulus-response pattern produces a learning curve. The interval between the stimulus and response shortens to a certain point and then levels off. For example, with a great deal of practice the reaction time to sound may become as little as 100-120 ms.[13]

Even when learning has occurred, however, there is still a variation in the individual's response from day to day and from reaction time

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[11] E. Duffy, Activation and Behavior, op. cit.

[12] H. Schlosberg and J. W. Kling, "The Relationship Between Tension and Efficiency," Perceptual and Motor Skills, Vol. 9 (1959), p. 395.

[13] Woodworth and Schlosberg, op. cit., p. 9.

to reaction time on the same day in the same session. There are many reasons for this variation, one of which may be changes in the level of activation from moment to moment.

Studies of Activation by Means of Various Physiological Measures

Observation of every-day behavior seems to point to a relationship between level of activation and performance. A number of studies have attempted to put this observation to experimental test.

Using muscle tension as the measure of activation and the learning of nonsense syllables as a measure of performance, Bills found that:

> By all three criteria of learning efficiency [(1) Number of presentations needed to learn a list of nonsense syllables, (2) Number of correct responses, (3) Per cent saved in relearning], "tension" is shown to be more efficient as a work condition than normal [or non-tension conditions].[14]

Freeman, also measuring muscular tension, reported that the time of a non-voluntary withdrawal from an electric shock lengthens with relaxation, which would be a point on one end of the continuum of activation, while hypertension, at the other end of the continuum, "decreased the accuracy of discrimination" between the intensity of two electric shocks.[15]

Stroud, in studying muscular tension and its relation with stylus maze learning, found that when there were more mistakes made in solving the maze, the tension was higher, but he concluded that, generally speaking, "the rate of learning is materially affected in a positive way by arti-

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[14]A. G. Bills, "The Influence of Muscular Tension on the Efficiency of Mental Work," American Journal of Psychology, Vol. 38 (1927), p. 231.

[15]G. L. Freeman, "The Facilitative and Inhibitory Effects of Muscular Tension Upon Performance," American Journal of Psychology, Vol. 45 (1933), p. 43.

ficially inducing tension."[16]

It is obvious from the preceding discussion that the relationship between muscle tension and performance is not simple; that increased muscle tension (or activation) may facilitate performance or inhibit performance.

Several investigators have found a curvilinear relationship between activation and performance--that is, performance is increasingly efficient until a certain level of tension is reached and then, with a further rise in tension, the quality of performance decreases.

Along these lines Courts, working with experimentally induced muscular tension and memorization, reported that, "With successive degrees of dynamometer tension, induced by gripping with the right hand, memorization is progressively more efficient until the optimal tension is reached. . . Higher degrees of tension result in successive decrements in performance."[17]

Freeman got similar results in a study of muscular tension and mental work, and he states:

> . . . while tension is a factor normally contributing to the facilitation of mental work, it may become an inhibitor of precise performance. Tension was notably increased under conditions of "supermaximal" effort; and concomitantly, the speed of addition increased and accuracy decreased.[18]

He also reports that the task observed seems to determine whether tension

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[16] J. B. Stroud, "The Role of Muscular Tension in Stylus Maze Learning," Journal of Experimental Psychology, Vol. 14 (1931), p. 630.

[17] F. A. Courts, "Relations Between Experimentally Induced Muscular Tension and Memorization," Journal of Experimental Psychology, Vol. 25 (1939), p. 225.

[18] Freeman, op. cit., p. 32.

will be facilitative or inhibitory. In a simple task, work output seems to increase as tension increases, while with more complex tasks output decreases after a certain level of tension has been reached.[19]

Malmo,[20] however, cites a study by Finch in support of the hypothesis that simple tasks also are inhibited by an unusually high level of activation. Finch reported on the volume of salivary secretion in dogs after varying periods of food deprivation. The relationship of salivation to food deprivation was curvilinear; that is, a few hours after food deprivation secretion was low; following 72 hours of food deprivation, salivary secretion was at its maximum; after 96 hours of food deprivation, the volume of secretion was again low.[21] To this writer any connection between Finch's work and activation appears strained and far-fetched. Finch used no measures of activation and does not indicate whether the behavior of the dogs was excited or lethargic. Although the hypothesis that both simple and complex tasks are inhibited by an extremely high level of activation may be valid, studies of this type do not seem to provide sufficient data to support the theory.

For many years a relationship between the level of activation and the electroencephalogram has been recognized. In fact, the classification of "brain waves" according to their frequency and amplitude and the

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[19]Ibid., p. 37.

[20]R. B. Malmo, "Activation: A Neuropsychological Dimension," Psychological Review, Vol. 66 (1959), p. 369.

[21]G. Finch, "Hunger as a Determinant of Conditional and Unconditional Salivary Response Magnitude," American Journal of Physiology, Vol. 123 (1938), pp. 379-382.

description of behavior which parallels these changes, would seem to make such a relationship obvious. The slow waves, called delta, ranging from 0.5 to 3 or 3.5 cycles per second, are associated with deep sleep. Theta rhythms, from 4 to 7 cycles per second, represent the early stages of sleep. In a normal adult subject, resting but not asleep, alpha rhythms of 8 to 13 cycles per second can usually be detected.[22] Beta waves (14 to 25 cycles per second) and gamma waves (26 to 50 cycles per second) appear to be at the other end of the continuum where the level of activation or excitement is high. As Malmo states: "...the pioneer EEG workers observed definite changes in EEG pattern accompanying major shifts in the conscious state of the S [subject]. Moreover, they recognized a continuum of increasing activation usually referred to as the sleep-waking-excitement continuum..."[23]

Freeman reports high correlations between EEG rhythms and general metabolic level,[24] and between EEG rhythms and "changes in the excitation level of the skeletal muscles and autonomic tissues."[25]

It seems to this writer that the EEG is the most direct and, hence, the most accurate measure of changes in the level of activation. The electroencephalograph, however, is an extremely expensive and highly complex piece of apparatus. This and the training required for the inter-

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[22] C. W. Simon and W. H. Emmons, "EEG, Consciousness, and Sleep," Science, Vol. 124 (1956), p. 1069.

[23] Malmo, op. cit., pp. 367-386.

[24] G. L. Freeman, "Cortical Autonomous Rhythms and the Excitation Levels of Other Bodily Tissues," Journal of Experimental Psychology, Vol. 27 (1940), pp. 160-171.

[25] G. L. Freeman, The Energetics of Human Behavior (Ithaca, N. Y.: Cornell University Press, 1948), p. 62.

pretation of the electrical activity recorded make the use of the electroencephalograph almost an impossibility in an undergraduate study.

Studies of the Electrical Activity of the Skin

There are a number of studies which have demonstrated a relationship between electrical activity of the skin and certain states of the organism. As a result of these studies, it is generally agreed that conductance is low (or resistance is high) when the organism is relaxed or drowsy, and that conductance is higher (or resistance is low) when the organism is more alert.[26]

Darrow, studying palmar conductance in relation to word association tests, found that the subject produced more words at a greater speed when his conductance was high. He concludes, "Apparently any stimulating condition which is not too severe and which will 'wake a person up' and increase 'energy mobilization' [or activation] and palmar conductance may improve performance.[27] Unfortunately, Darrow did not introduce a "severe" stimulus and consequently does not show what the effects of such a stimulus might be.

In a recent study Stennett tested the hypothesized curvilinear relationship between performance and activation. Using accuracy in an

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[26]M. M. White, "Relation of Bodily Tension to Electrical Resistance," Journal of Experimental Psychology, Vol. 13 (1930), pp. 267-277; C. W. Darrow and G. L. Freeman, "Palmar Skin Resistance Changes Contrasted with Non-Palmar Changes and Rate of Insensible Weight Loss," Journal of Experimental Psychology, Vol. 17 (1934), p. 747; and C. W. Darrow, op. cit., p. 76.

[27]Darrow, op. cit., p. 80

auditory tracking task as his criterion for quality of performance and measuring activation by both palmar conductance and muscle-tension, he found evidence to support the hypothesis. Thirty-one subjects participated. "The hypothesis held," Stennett states, "regardless of whether palmar conductance level or the EMG response of any one of four different muscle groups was used as the criterion of arousal."[28]

Duffy summarizes her position on the hypothesized relationship between activation and performance in the following way:

> When performance has been observed to vary under certain conditions, such as those of drowsiness, of fatigue, or of "emotion," it is suggested that the variations may be due, at least in part, to the effect of varying degrees of arousal. The disorganization of responses frequently reported during "overmotivation" or "emotion," for example, may be conceived of as resulting in part from too high a degree of arousal. Such a condition would be represented at one end of the U-shaped curve. A similar disorganization of response, found sometimes during drowsiness or fatigue, would be represented at the other end of the curve showing the relationship between arousal and performance.[29]

Schematically, Malmo presents the same theoretical concept:

Activation level:	Low	Moderate	High
Expected performance level:	Low	Optimal	Low[30]

Although there are several studies concerning the level of activation and performance, there are few that have approached the problem

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[28] R. G. Stennett, "The Relationship of Performance Level to Level of Arousal," Journal of Experimental Psychology, Vol. 54 (1957), p. 60.

[29] E. Duffy, "The Psychological Significance of the Concept of 'Arousal' or 'Activation'," Psychological Review, Vol. 64, No. 5 (September, 1957), p. 268.

[30] Malmo, op. cit., pp. 367-386.

using electrical activity of the skin as the measure of activation and reaction time as the measure of quality of performance.

One of the few experimenters to attack this specific problem was G. L. Freeman. Using twenty undergraduate subjects and correlating both finger oscillation and reaction time with skin resistance, he found, "In general it seems that persons of high initial resting reactivity [high level of conductance or activation]...do not increase performance under raised standards as much as those with a relatively lower initial reactivity level [relatively lower level of conductance or activation]."[31] It must be emphasized here that this inhibition in performance seems to be a function of the initial level, for in the same study Freeman reported "...a tendency for persons who showed the greatest drop in skin resistance [the greatest rise in conductance and activation]...to attain the supernormal standard a greater number of times."[32]

In a similar study with one subject, Freeman was able to establish a curvilinear relationship between the level of activation and reaction time. He measured palmar skin resistance and reaction time in 105 trial observations under varying conditions, or skin resistance and reaction time at varying levels of activation. The subject reported his "psychological condition" five times during the course of the experiment. In two of these instances, when the subject felt he was putting forth his "greatest possible effort," his palmar <u>resistance</u> measured 15,000 ohms (a conductance

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[31]G. L. Freeman, "The Relationship Between Performance Level and Bodily Activity Level," *Journal of Experimental Psychology*, Vol. 26 (1940), p. 605.

[32]*Ibid.*

of 66.66 micromhos) and his reaction time, 145 ms, in contrast to a resistance of 45,000 ohms (conductance = 22.22) and a reaction time of 120 ms when he reported himself to be at his "typical work level."[33] In other words, when the subject's level of activation had risen beyond a certain point, in this case around the level of 22.22 micromhos of conductance, his reaction time lengthened, or his performance became less efficient.

The use of only one subject, however, makes Freeman's results barely acceptable. To remedy this, Schlosberg, becoming interested in the problem, turned the task of repeating Freeman's experiment over to a student. With the added dependent variable of hand steadiness, the student established a relationship similar to that established in the previous study. She then repeated the experiment with five other subjects but accumulated "barely enough [data, 10 sets per subject]...to suggest that their performance and skin conductance might show the same general curvilinear relationship."[34] In regard to this particular experiment Schlosberg concludes:

> Later events...suggest that there may have been selection of data to support the hypothesis in the original experiment. We now have no confidence in the accuracy of our first E...[35]

Schlosberg and Kling, feeling it necessary to repeat the experiment before the publication of such positive results, could not support the conclusions of the student's experiment "...although we have tried it,

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[33] *Ibid.*, p. 608.

[34] Schlosberg and Kling, *op. cit.*, p. 395.

[35] *Ibid.*, p. 396.

both in its original form and with variations on 22 Ss, with from 2 to 57 sessions per S."[36]

Obviously, experimental results in this particular area are inconclusive. The study supporting the hypothesis is subject to criticism because of the use of only one subject. Doubt of the experimenter's reliability handicaps the second study. Incomplete reporting of procedure and results by Schlosberg and Kling makes it impossible to judge the value of the work and for this reason heaps confusion on the entire area.

Because of this confusion, the present study was undertaken. It was hoped that either positive or negative results would be beneficial in this specific field of research.

Apparatus and Procedure

In this study the apparatus used to measure level of activation as indicated by skin resistance was a Lafayette galvanometer, model 601A. According to the company's operating instructions it is an "...AC operated, DC amplifier, utilizing a modified Wheatstone bridge circuit..." The galvanometer measured the "apparent" resistance of the skin to a minute electric current passed through its surface, in this case the palms of the hands. In using resistance, no allowance is made for a certain distortion in results produced by the various levels of resistance from which the drop occurs. A great drop in resistance from a high resting level is not comparable to a smaller drop at a lower level, for both may represent the same amount of metabolic activity. In transforming the data to con-

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[36]*Ibid.*

ductances, however, this distortion is corrected.[37] Therefore, the data were converted into conductances, the reciprocal of resistance.

In order to get a reading the apparatus had to be constantly readjusted by the experimenter, making it necessary to record only at particular intervals and thus preventing a more desirable continuous recording.

The electrodes[38] were composed of a layer of zinc, a layer of manganese dioxide, and a layer of cotton contained in a plastic cup measuring approximately one inch in diameter. Ordinarily the electrodes are attached to the subject by elastic bands. It was feared that during the course of experimentation these elastic bands would stretch and the pressure on the palms would not remain constant. In view of this, non-stretchable nylon watch bands were used, replacing the elastic. Rubber sponges soaked in saline solution were applied directly beneath the electrodes.

Equipment used for the measurement of reaction time was kept as simple as possible. A telegrapher's key, nailed to a board on the floor in front of the subject, was attached to a clock. Attached to the same clock was a Hunter timer. The timer was also connected to a foot pedal operated by the experimenter and to a signal light facing the subject.

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[37] C. W. Darrow, <u>op</u>. <u>cit</u>., p. 74.

[38] The electrodes were supplied by R. C. Davis of Indiana University. Davis has done considerable work on apparatus involved in the measurement of skin resistance. At the outset of this study it was planned to use the Davis galvanometer which corrected some of the outstanding defects in the regular type of galvanometer used in problems of this nature. It was found, however, that the Davis galvanometer was not operating properly and that there was not sufficient time to remedy this. Consequently, the Lafayette galvanometer was used.

All of the equipment was on the same electrical circuit. When the experimenter pressed the foot pedal, the timer and the signal light were turned on. Through the timer the interval between the light, or "ready" signal, and the buzzer sound to which the subject was instructed to respond could be varied to prevent the learning of a temporal sequence by the subject. Intervals between the "ready" signal (the light) and the sound-stimulus varied, in steps of one-half seconds, from two to four seconds. The clock measured reaction time in 1/120 of a second.

During the sessions the subject sat with her foot on the telegrapher's key. The experimenter closed the electrical circuit by placing her foot on the foot pedal and, consequently, turning on the signal light. After a variable period the current passed through the clock, causing it to buzz and the hand on the clock to rotate. Upon hearing the buzzer the subject lifted her foot from the telegrapher's key, broke the electrical circuit, and stopped the clock. Thus a measure of reaction time was obtained. This procedure was repeated thirty times during each session.

The general procedure for each of the sessions was as follows:

The subject entered a sound-proof room. She sat in a chair with arms padded with sponge rubber to enable her to keep her arms in the same position in comfort for the duration of the session. The electrodes and sponges soaked in saline were attached to the palms of her hands. After a saturation period of ten minutes the reaction time trials began.

For each trial, measurements of skin resistance were taken immediately before the presentation of the "ready" signal and immediately preceding the sound of the buzzer. This gave readings for a general level of skin resistance and for a changing resistance, in some cases a galvanic skin response.

Following the fifteenth trial, there was a rest period of four minutes. After the rest period the trials were continued.

At the end of each experimental session, then, there were thirty recorded readings of a general level of conductance, thirty recorded readings of a changing level of conductance, and thirty recorded readings of reaction time.

As previously stated, the experiment took place in a sound-proof room. This prevented outside noises from distracting the subject, provided a uniform environment for each session, and enabled the experimenter to keep the room temperature at a constant 76° F.

A cardboard partition separated the subject from the experimenter to lessen the chance exchanging of any cues between the two.

When the study was in its planning stages, it was decided to depend, as far as possible, on diurnal changes in skin resistance to vary the level of activation to the extent necessary for a great enough range to produce the hypothesized curve. It was found, however, that these variations only gave a small range. To remedy this a cot was placed in the sound-proof room and the subject was asked to rest, or sleep if possible, before the trials began. With the first subject an all night session was held. The subject was awakened and tested at regular intervals during the night. The sessions immediately following rest or sleep extended the lower limit of the continuum of conductance or activation, but in these particular experimental circumstances there was no feasible method, although several rather drastic ones were considered, for extending the upper limit of the continuum.

It would have been more desirable to have arranged the sessions in a balanced order, holding one third in the morning, one third in the afternoon, and one third in the evening. This scheme was followed as closely as possible, but the sessions had to be arranged to suit the convenience of the subjects and the experimenter and to avoid any conflicts with academic schedules.

Through a lucky accident, the first clock used was broken. In substituting another clock, it was discovered that the first one had been defective. The readings from this clock, however, were proportional and were fairly reliable if not combined with readings from a properly working clock. As a result of this, the sessions with the first subject had to be halted when sixteen sessions of thirty trials each had been completed. Another subject was included and the experiment began again. Including trials in which reaction time was practiced, there were sixty-five experimental sessions, twenty-one with the first subject, twenty-two with the second, and twenty-two with the third subject.

Results

Skin resistance readings were converted into conductances, and the data for all three subjects were plotted in several ways on different graphs. Sixteen sessions of thirty trials for the first subject and seventeen sessions of thirty trials for both of the other subjects were plotted. Those sessions involving the practicing of reaction time only were not plotted on these graphs. Each individual reading of conductance immediately preceding the sound stimulus was plotted against each individual reaction time.[39] The data from each subject were also plotted in terms of mean or average conductance for half sessions (or fifteen trials) and mean reaction times for half sessions.[40] To determine whether, in these particular cases, the general level of conductance greatly changed the shape of the graph, the general level of conductance readings taken before the "ready" signal was given were plotted against the mean reaction time for half sessions for one subject.[41] When this graph was compared with the graph on which conductances preceding the stimulus were plotted,[42] it was decided that there was not a difference sufficient to warrant the plotting of individual trials for each subject.

Upon visual inspection none of these graphs presented a consistent relationship between level of activation and reaction time. Because of this, further statistical treatment would have been superfluous.

The range of conductances preceding the sound stimulus for the first subject was 10 to 526 micromhos (a range considerably greater than that which Freeman obtained in his study with one subject, his range being 14.26 to 100 micromhos). The range for reaction time was from 6/120 of a second to 26/120 of a second. For the second subject the conductance range was 69 to 178 micromhos, and the reaction time varied from 12/120 of a second to 33/120 of a second. For the third subject the range of conductance was from 66 micromhos to 285 micromhos, with a reaction time range of 8/120 to 37/120.

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[39]Graphs I, II, and III.

[40]Graphs IV, V, and VI.

[41]Graph VII. [42]Graph IV.

It is of interest to point out that for every subject the range was greater than that obtained by Freeman. Data from only one subject, the first, includes Freeman's exact range. If one covers the part of the graph not included in Freeman's range, or, in other words, if one disregards all readings above 100 micromhos of conductance, a curve similar to the one obtained by Freeman, i.e., a curvilinear relationship, becomes visible. Since only one subject fell in this segment of the continuum, no definite conclusions can be reached, but this might cause one to ask if it is possible that the relationship is curvilinear for only a certain segment of the continuum of conductance.

Conclusion

The data from this study do not in any way support the hypothesized curvilinear relationship between reaction time and level of activation, as measured by skin conductance. In this largely unexplored area of research, results, either positive or negative, are difficult to interpret. It may well be that the relationship does not exist. It was not demonstrated in this study. Although it is the opinion of the directors of this project that the study was more carefully carried out than that of either Freeman or Schlosberg and Kling, certain defects in the apparatus and procedure make it impossible to claim that the hypothesis was definitely negated. As yet, no completely satisfactory study has been reported in this field. Since the hypothesis is of relatively recent origin and is still in the early stages of experimental exploration, one would expect that the first approaches to the problem would be faulty.

One of the greatest handicaps in this study was the fact that activation could not be varied systematically by the experimenter. Because of this, there is a preponderance of readings of conductance at certain levels and only a few readings at other levels. This in itself might obscure any relationship that exists.

On the other hand, it is the opinion of this experimenter that reaction time is too simple a measure of response to yield positive results. A more complex measure of performance might have done so. Although the ranges in conductances for all three subjects were greater than those reported by Freeman, it is still possible that activation never reached a level high enough to impair responses in these subjects. In a comparable range the responses of other subjects might have become impaired.

As in the past, it is apparent that those interested in the problem must await the standardization of physiological measures which will detect the significant aspects of organismic change in this area. They must also await a sufficient accumulation of data to allow a common method of attack, one which can be repeated and corroborated by other experimenters in the field.

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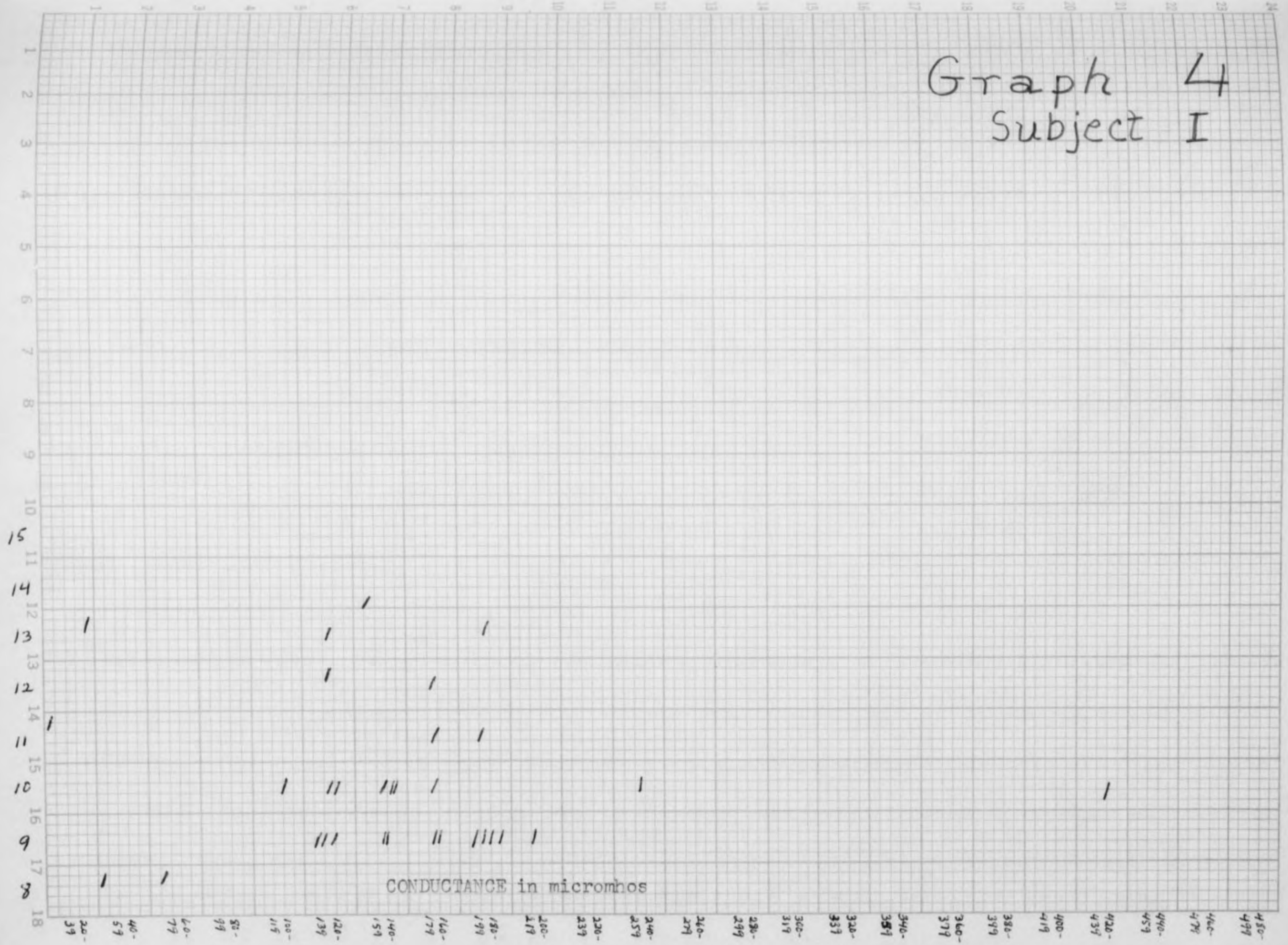
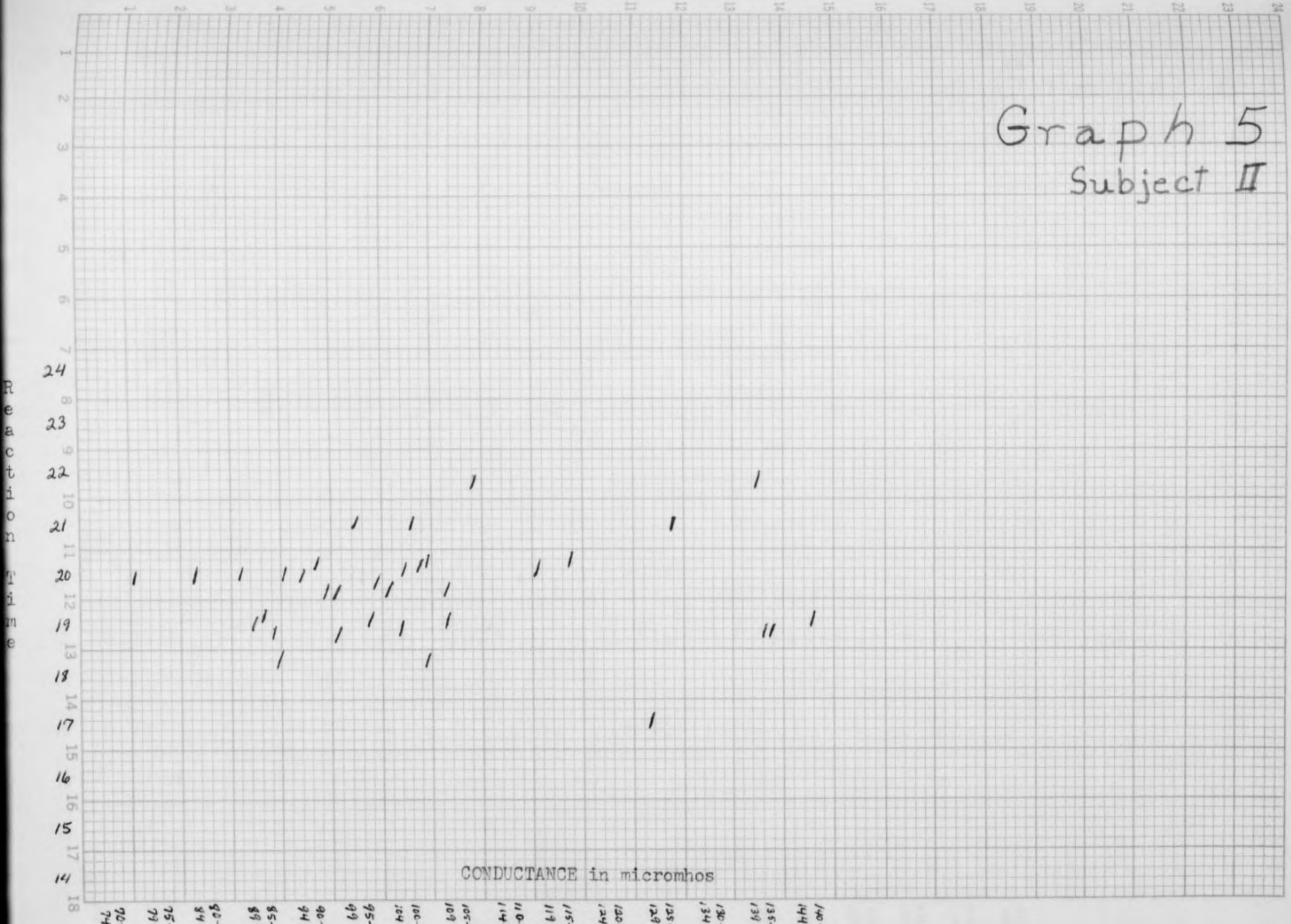
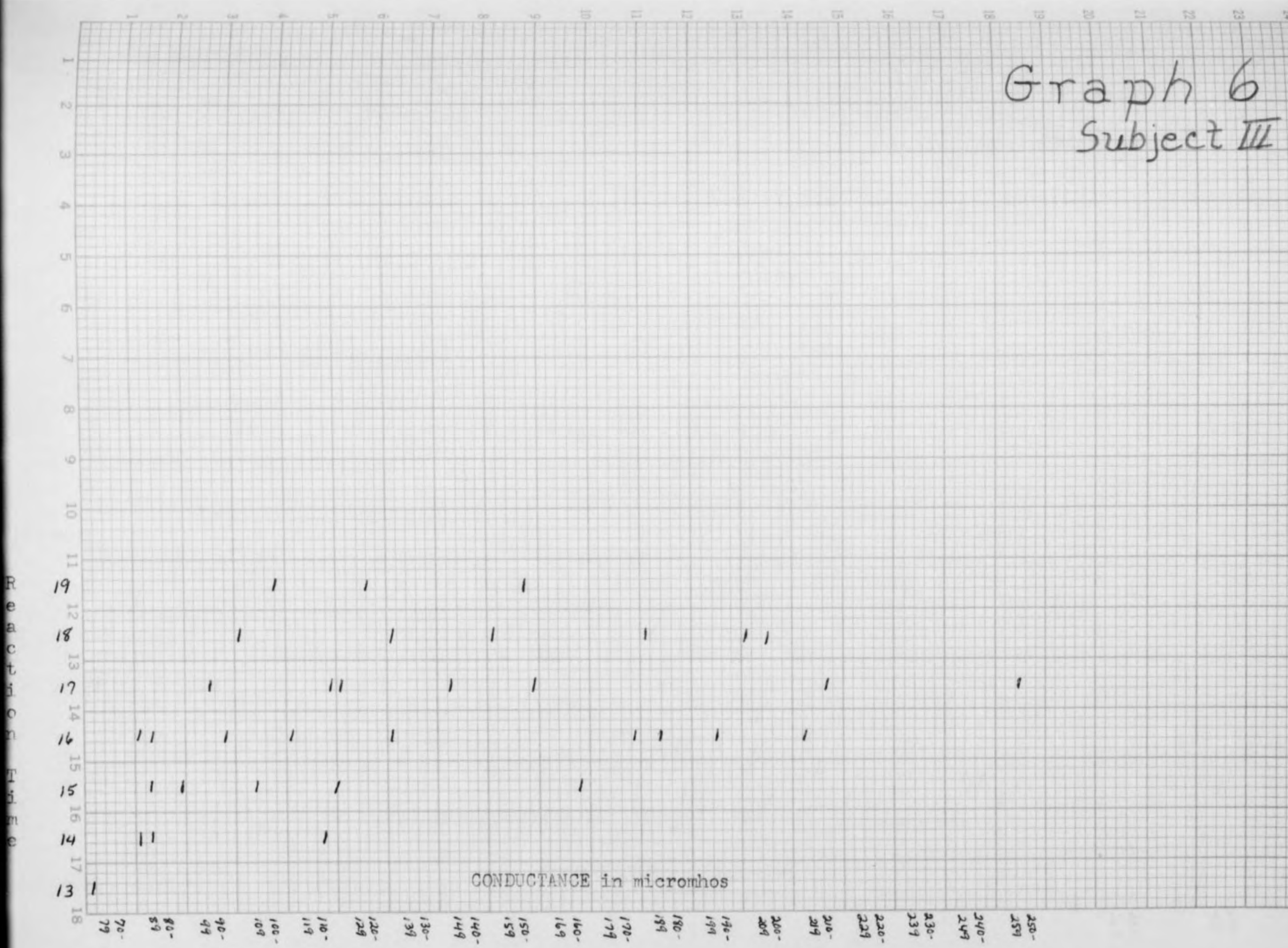
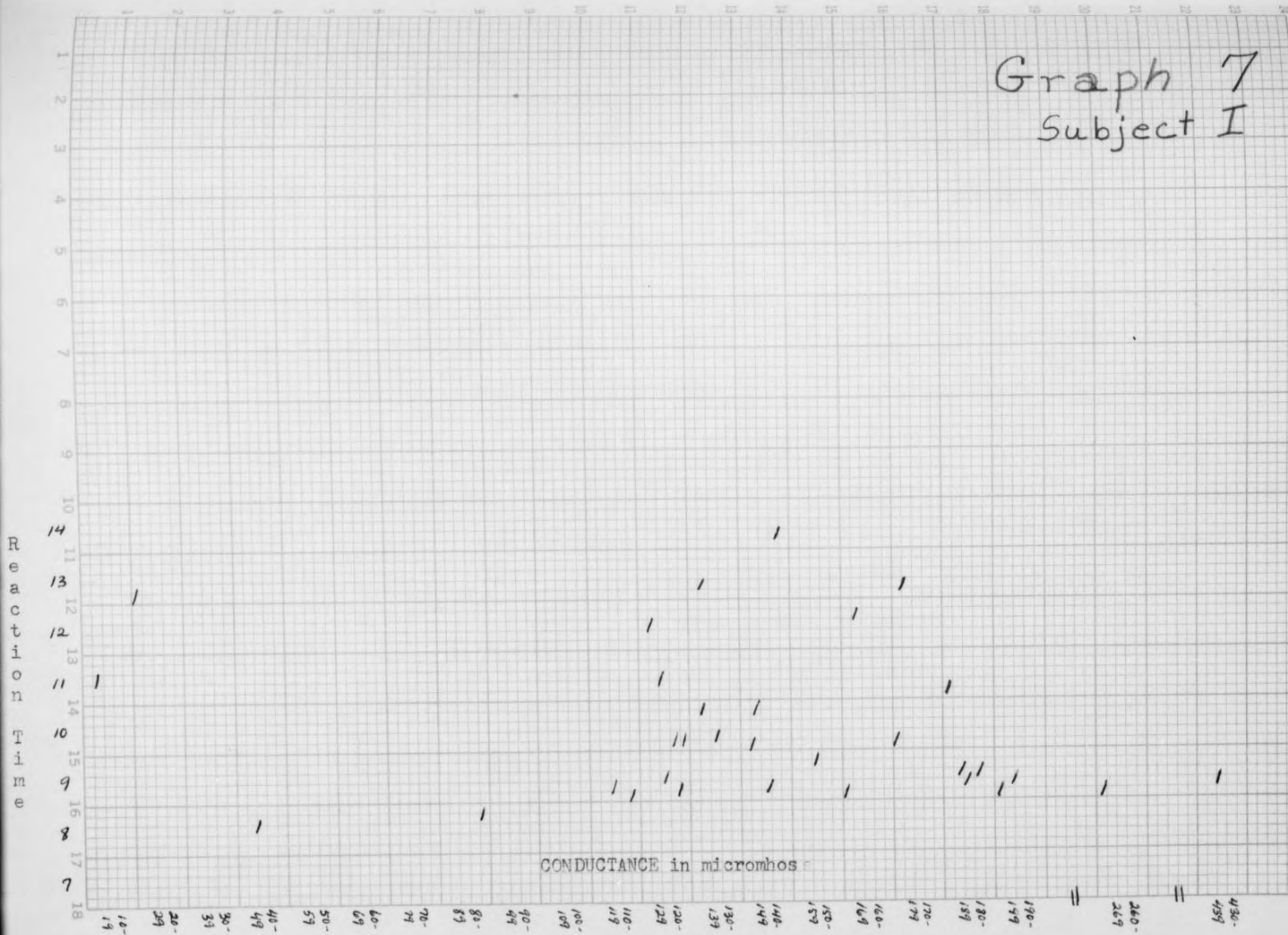
Graph 4
Subject I




Graph 5
Subject II
Reaction Time
24
23
22
21
20
19
18
17
16
15
14
CONDUCTANCE in micromhos
70-74
75-79
80-84
85-89
90-94
95-99
100-104
105-109
110-114
115-119
120-124
125-129
130-134
135-139
140-144


Graph 6
Subject III
Reaction Time
CONDUCTANCE in micromhos
19
18
17
16
15
14
13
70-79
80-89
90-99
100-109
110-119
120-129
130-139
140-149
150-159
160-169
170-179
180-189
190-199
200-209
210-219
220-229
230-239
240-249
250-259



Graph 7
Subject I
Reaction Time
14
13
12
11
10
9
8
7
CONDUCTANCE in micromhos
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100-109
110-119
120-129
130-139
140-149
150-159
160-169
170-179
180-189
190-199
260-269
450-459